APPENDIX VI.

[Vide answer to question No. 1855 asked by Sriman Biswanath Das Mahasayo at the meeting of the Legislative Council held on the 25th March 1929, page 721 supra.]

I

Note by Mr. R. N. Arogyaswami Mudaliyar, Executive Engineer, Ganjam division, dated 12th October 1912, on improvements to the Rushikulya System.

I. The system consists of the following main works :—

(1) Russellkonda reservoir with a capacity of 2,148 million cubic feet, with a catchment of its own of 25 square miles and fed by the Gulleri channel (taking off from the Mahanadi above the Gulleri anicut) which is capable of carrying into it a discharge of 660 cusecs.

(2) Surada reservoir with a capacity of 1,420 million cubic feet supplied entirely from its own catchment of 200 square miles.

(3) The Goomsur head works and the Mahanadi canal on the Mahanadi (where it has a catchment of 970 square miles) with an extent of 12,000 acres under direct irrigation.

(4) The Janamilli head works and the Rushikulya canal on the Rushikulya river (where it has a catchment of 850 square miles) with an irrigation of about 92,000 acres.

II. The object of this note is to examine the irrigating capacity of the present system and works, and to see if it is labouring under any inherent and unavoidable shortcomings. The question as to whether at present the system is being worked to the greatest advantage, and whether irrigation under it is capable of expansion will also be considered. The works necessary to use to the fullest advantage the supply that is already available and what is now going to waste will also be referred to.

III. Rainfall and its chief characteristics.—Rainfall statements for the chief stations in the district are attached—for the sake of convenience—as appendix I to the report. Russellkonda may be taken as typical of the catchment of the reservoirs and the rivers above the anicuts, and Berhampur for the irrigated area.

The years of lowest recorded rainfall for the district are 1877, 1888, 1891, 1896, 1905 and 1907. It will be noticed that in all these years, there is never any failure of the south-west monsoon at Russellkonda although somewhat in defect in some years, while at Berhampur, the failure is due chiefly to the north-east monsoon again, the south-west also being in defect in the years 1877, 1888, 1901 and 1905. A perusal of the tables will show that it is the failure, partial or total, of the north-east monsoon that has to be provided for, while there may occasionally be a shortage of the early south-west monsoon in the irrigated tract in the months of June and July. Storage is required for saving crops in October and November in the years under reference and in others, while in the case of shortage of rain in June and July water is required only for saving seed-beds. For the latter the supply in the rivers is quite sufficient. No transplantation is possible or advisable till the south-west monsoon breaks and heavy rainfalls.

[25th March 1929

Taking the 30-year period from 1878 to 1907, it is found that this consists of 18 good years in which the rainfall between June and November varies from 38 to 60 inches, 8 unfavourable years in which the rainfall varies from 32 to 35 inches, and 4 bad years in which the average for the same period is about 25 inches. Even in the latter series of four bad years it is unlikely that irrigation under the project will suffer to any *serious* extent.

Every year of the series has its own peculiarities, but the general features of the rainfall are—

(1) That as a rule there is no failure of the south-west monsoon ;

(2) That while in a few years there is some shortage of rain in August (the period of transplantation), there is seldom a combination of a poor August (at Berhampur) following a poor July ;

(3) That even in periods of poor rainfall in August over the ayacut (Berhampur) there is heavy rain in the upper catchment of the rivers (Russellkonda) ;

(4) That the rainfall (and river supply) conditions are generally such as to leave the reservoirs practically full (other conditions being suitable) at the end of September ;

(5) That a poor September is seldom (except in 1896) followed by a failure of rain in October and November so that (other conditions being suitable) reservoirs could be filled in October or November if not at the end of September ;

(6) That a failure of rain, total or partial, might often be expected in October or November, and often in both months, and that it is this failure that has to be guarded against by provision of adequate storage.

IV. Irrigation sources and supplies available.—As explained above, the system derives its supply at present from the Mahanadi and Rushikulya rivers alone. Before proceeding to consider the possibility of other sources being pressed into service, the supplies utilized at present and the surpluses passed to waste in these sources will be referred to briefly. As appendices II, III, IV, V and VI respectively to this report the following statements are enclosed :—

(1) Statement of head sluice discharges and surplus at Gulleri anicut for the years 1900–01 to 1911–12.

(2) Statement of head sluice discharges and surplus for Goomsur anicut for the same period.

(3) Statement of head sluice discharges and surplus for the Janamilly anicut for the same period.

(4) Statement of gauge reading and quantities stored in Russellkonda reservoir for the same period.

(5) Statement of gauge reading and quantities stored for Surada reservoir for the same period.

Taking the Mahanadi first, it will be seen that in the series of twelve years there is quite a large volume of surplus if adequate storage was available, for the irrigation of a considerable area of extra land (vide remarks lower down). The only exceptions to this rule are the years 1901–02 and 1905–06. In 1901–02, the Russellkonda reservoir starts with a gauge of 40·45 in June (1,634 million cubic feet, carried over from the end of the previous season) and the gauge on the 1st September is 40·69, while on the

1st November it is 30·50 (equivalent to 885 million cubic feet). At the Gulleri anicut, there is a surplus of about 1,300 million cubic feet, which on the supposition that the Gulleri channel was made capable of carrying it, could have been diverted into the reservoir. There is, therefore, just enough water in this year to meet the requirements of existing irrigation and no more, on the supposition that no water was reserved in Russellkonda reservoir from the end of the previous season (i.e., 1900–01).

In the year 1905–06, the reservoir starts with a gauge of 40·55 (or 1,643 million cubic feet) in June, and on the 15th November the reading is 32·95 (or 1,045 million cubic feet). The total surplus at the Gulleri anicut for that year is only 293 million cubic feet. If the supply from the end of the previous season is not taken into account, and if it be assumed that the same issues as at present took place from the reservoir, there would be a deficit on the 15th November of about 300 million cubic feet. At the Goomsur anicut, however, there is a considerable amount of surplus in the four months, July to October; but owing to the fact that only a small quantity (what is available at Gulleri anicut) could be stored in the Russellkonda reservoir, the large surplus at Goomsur could not be utilized for any considerable area of extra irrigation—probably not more than another 2,000 or 3,000 acres at the highest.

In all other years, there is ample surplus—with adequate storage—for a large area of extra irrigation.

Considering the case of the Janamilli anicut and taking the surpluses here along with the statement for Surada reservoir, it will be seen that for the period under reference, there are four bad years, 1901–02, 1905–06, 1906–07 and 1907–08. Taking the last two years first, it will be seen that for these years there is ample surplus available at Goomsur anicut and that with the aid of the Mahanadi canal, ample water could be got not only for present requirements but also for extra irrigation. The surpluses available in the Rushikulya are sufficient to leave the Surada reservoir full on the 1st October of each of these years (without any reservation of supply from the previous season), if adequate arrangements are made for filling the reservoir. Taking the case of the other two years (1901–02 and 1905–06), it will be seen that the Mahanadi could give no help in these years, and that although there is enough surplus in the Rushikulya to fill the reservoir, without the necessity of reserving water in the previous season, the surpluses available are not sufficient for any extra irrigation. In all other years, there is ample surplus to warrant a considerable extension of irrigation (the extent of which will be referred to later on), provided adequate storage is available.

Besides the above sources, it will be seen from what follows that it is proposed to utilize also the supplies available in the Godohollo and Baguva rivers by suitable works. It is expected that by this means a large extra supply will become available, which will not only help existing irrigation, but also warrant a considerable extension of irrigation.

V. Defects in the present system.—The present system of canals has been designed with a duty of 100. It is obvious that great reliance has been placed on the rainfall.

For transplantation without the aid of rain, a duty of 100 is quite inadequate; but from the remarks made above concerning rainfall, it will be seen (1) that there is seldom a failure of the south-west monsoon, (2) that a

shortage of this monsoon merely means postponement of the transplantation, as no transplantation is possible without the aid of rain and (3) that water during the early part of the season or when there is a shortage of the early rains is only required for supplying seed-beds, and probably a limited amount of transplantation (with rain) in the upper reaches of the channels. Once transplantation is over, the duty of 100 is sufficient to meet all demands. Is it necessary to alter this? Although it is desirable for purposes of transplantation to work to a much lower duty—say 60—when there is no rain, the system so far has done well. The present channel sections allow of our running a discharge with a duty of even 80, and going by the experience of the past, it is unnecessary to do more.

Delay in transplantation is really immaterial and it is rare. There is enough supply for seed-beds always.

Next, the headworks of both the Mahanadi and the Rushikulya canals require improvement. At the Goomsur anicut it is not possible to secure full supply for the canal without erecting a turf bund 2 to 2½ feet high over crest of anicut.

The river-bed above anicut has silted up largely and the first reach of the canal is being badly silted up. The improvements required to remedy this are of an urgent kind.

At the Janamilli anicut, 2 feet plank shutters are put up over crest and the arrangement is fairly satisfactory, but there is about 2 feet of silt in the first reach of the canal. The head sluice is placed rather in an awkward situation for avoiding silt, and it is desirable to improve matters.

As for the canals themselves there are still a large number of pipes in the banks which are a constant source of danger to the banks, and breaches have often taken place at sites of pipes, thus often leading to the cutting of supply at the time of maximum demand and giving the system a reputation for unsteadiness of supply which is not warranted by the actual conditions of supply. There are also some sluices with ventways larger than are justified by their ayacuts and these along with the pipes are a great source of wastage. Something has already been done in this matter and more remains to be done.

The banks themselves require strengthening in places, particularly at the approaches to aqueducts. The aqueduct wings are often too short and banks have not got proper slopes.

With reference to storage, the system provides a capacity of 3,580 million cubic feet. This storage is chiefly required during the months of October and November—from, say, the 1st October up to the 15th November. The draw on the storage during this period is often steady and continuous, while at other times it is generally small and for a shorter period. Taking a duty of 100 for discharge during the period (when paddy is nearing maturity), we require a discharge of 1,060 cusecs for 45 days, which is equivalent to about 4,134 million cubic feet. Even in the worst years (1901–02 and 1905–06) the rivers contribute about 1,300 million cubic feet—omitting the surplus over anicuts and through under sluices. So that, the supply available and the storage room are more than ample for present requirements. The difficulties in the matter have to be traced to other causes than to inadequate capacity.

25th March 1929]

It is the recuperative power of the reservoirs that requires improvement. Taking the case of the Russellkonda reservoir first, this has a capacity of 2,150 million cubic feet, and is supplied by the Gulleri channel which is capable of discharging 660 cusecs. It has also a catchment of its own of 25 square miles, which might contribute about 200 million cubic feet in a good year. The evaporation losses during the irrigation season will be about 500 million cubic feet; but omitting this and taking only the actual capacity of the reservoir, it will take 37 days to fill up with full supply running. To get 37 full-supply days, it would often take *three months* (or longer if a dry month intervened) since the number of full-supply days in a month is not more than 12. To make full use of the storage room available, the reservoir must be filled much more quickly, so that it might be fully prepared to perform its duty if a period of drought intervened.

Indeed, if the present arrangements of supply from the Gulleri channel continued, we do not require a reservoir of the present dimensions at all, since with a normal draw-off from the reservoir, which would arise if the present imperfections of draw-off at the Goomsur anicut and the Mahanadi canal were removed, a reservoir of half the present size would answer all requirements in a normal year. These points concerning the Russellkonda reservoir would have been noticed earlier, but for the fact that owing to the difficulty of holding up water to a sufficient height at Goomsur anicut, the water is drawn off only in small quantities with the result that a large balance is left over in the reservoir at the end of every season.

Another important reason for the small draw-off from the reservoir is the fact that the Mahanadi brings down a large and fairly steady supply which generally continues through the months of July, August and September, so that in spite of the shortcomings of the head-works, the Mahanadi canal contributes a considerable supply of Mahanadi water to the Rushikulya canal.

In consequence of this, the reservoir begins with a large balance generally and the poor discharge of the Gulleri channel has been sufficient therefore to fill it. It is obvious that if the highest efficiency is to be got out of the reservoir, the carrying capacity of the Gulleri channel must be doubled or trebled, so that the reservoir might fill in 12 full-supply days (or one month).

The case of the Surada reservoir is slightly different—although here also an increase in recuperative power is required besides an increase of capacity.

The storage room in this case is 1,430 million cubic feet at present; and the catchment basin is 200 square miles. A reference to the statement of gauge readings of the reservoir from the years 1901–02 to 1911–12 will show that the reservoir does not fill in the years 1901–02, 1902–03, 1905–06, 1906–07 and 1907–08, and that in other years it is only full in September or October. The necessity for altering this state of things has been long recognized and proposals have been under investigation for improving the supply. One of these proposals is to construct an anicut across the Johoro and turn a supply into the reservoir by means of a short channel.

This and other possible alternatives will be referred to in greater detail further on. Considering the large volume of surplus at the Janamilli anicut —all of which is now utterly wasted—and the great need for extra storage to meet current requirements and for extra irrigation, it is proposed also to increase the capacity of the reservoir. A similar proposal also for the Russellkonda reservoir will be referred to later on.

[25th March 1929

The project calculations give 1,755 million cubic feet as the capacity of the Surada reservoir, but from calculations since made based on contours taken in 1903–04 it is found that the actual capacity is only 1,430 million cubic feet.

While it is impossible to say that the reservoir has lost a capacity of over 300 million cubic feet since construction, it is certain that the Padma is filling up the reservoir with sand and silt at a fairly rapid rate. Taking the average monsoon rainfall as 36 inches and using Strange's tables (for an average catchment), the annual run-off from 200 square miles will be 4,140 million cubic feet. If the silt carried into the reservoir was $\frac{1}{360}$ by volume (a not unlikely figure for a torrent like the Padma), the amount deposited every year will be 16 million cubic feet. The reservoir will therefore fill up in 90 years.

As the reservoir has been holding water since 1891, it might have been filled up to the extent of 336 million cubic feet during the last 21 years. It seems almost certain that the reservoir has filled up considerably. The silt accumulation in front of the head sluice is particularly inconvenient as, on account of this, it is not possible to drain the low water in the reservoir. The need for increased capacity is therefore evident.

Extra capacity can be got at a comparatively small cost by raising the F.T.L. of the present reservoirs and no schemes for new reservoirs are likely to be considered in the near future (except as famine-relief works) on account of their prohibitive cost.

VI. Improvements proposed.—The improvements proposed will be dealt with in the following order :—

(1) Gulleri anicut and channel.
(2) Russellkonda reservoir.
(3) Goomsur anicut.
(4) Mahanadi canal.
(5) Girisola channel and supply channel from the Baguva.
(6) Surada reservoir.
(7) Janamilli anicut.
(8) Rushikulya canal and supply channel from the Godohollo.

(1) *Gulleri anicut and channel.*—This channel will have to be improved so as to make it capable of carrying, say, 1,500 cusecs at least. The present F.S.L. depth of the channel is 4 feet, and the head sluices are capable of carrying 557 cusecs with water at crest level of anicut as against the required full supply discharge of 660 cusecs. The channel is banked only on the left, and this bank in most places is very wide and high, so that the depth of flow could be increased considerably at small cost. The outlet crests could be raised, and the terminal weirs given extra water-way at a comparatively small cost. The only work on the channel presenting some difficulty is the Kottipada syphon. It will be necessary to put in extra vents here and probably the crest level of the lift wall and bed-level of the channel on the down-stream side may also be lowered.

The crest of the anicut will have to be raised 3 feet—1 foot of solid wall with 2 feet plank shutters over it. The maximum flood level at the anicut is already very high and no doubt some extension of the anicut will be necessary on the left bank, which can be easily done.

25th March 1929]

Another difficulty here is the want of sufficient scouring power. In many years the total river discharge is not such as to enable the undersluices to be worked effectively. The river bed above anicut is considerably filled up with sand, and a large quantity of it is being continuously forced into the head sluice silting up the first two miles of the channel below. The addition of three more vents to the undersluices and the fitting up of new gearing for the head sluice with shutters in two tiers (so that the bottom shutter may always remain closed in a flood) would remedy matters to a considerable extent. The present sill of head sluice is 3·75 feet above undersluice sill; but, as stated above, the river bed above is filled up to a much higher level.

(2) *Russellkonda reservoir.*—It is proposed to raise the F.T.L. of the reservoir by 3 feet. The head sluice is capable of discharging the whole surplus from the catchment of the reservoir, so that the weir crest may be raised by solid masonry or 2 feet plank shutters may be put in over 1 foot of masonry. The top of bund is 12 feet above the present F.T.L., the top width being 8 feet at the deepest part. The slope of the front revetment is 2 to 1 below and $1\frac{1}{2}$ to 1 above F.T.L. The top of revetment is 6 feet above F.T.L and the top of puddle wall 3 feet above F.T.L.—vide typical section of bund attached. The extra capacity by the raising will be about 320 million cubic feet, the probable total capacity of the reservoir after the improvement being 2,470 million cubic feet.

(3) *Goomsur anicut.*—The F.S.L. at the anicut must be raised 2 feet. To secure this it has been proposed to fit up falling shutters. Whatever the final decision on this matter may be, it will be necessary to provide extra scouring power. The excavation of the Girisola channel on the left bank will necessitate the opening out of a scouring sluice on that bank. The extra scouring power may be got by cutting down a portion of the crest by 4 feet and fitting up three 30 feet lift shutter spans, with 6 feet shutters. In the case of this anicut it may be noted that the working of falling shutters will be difficult and attended with danger as there is a sheer drop of 7·2 feet in rear. The same remark applies to plank shutters.

It will be necessary to fit up for the Mahanadi canal head sluice also the same kind of gearing (with shutters in two tiers) as has already been referred to in connexion with the Gulleri channel.

(4) *Mahanadi canal.*—The raising of the F.S.L. at the anicut will enable the Mahanadi canal to be run with a maximum depth of 8 feet—to which it was originally designed—although owing to the silting up of the upper reaches and the insufficient height of anicut crest it has not been possible to run this depth hitherto. The banks of the canal will require strengthening in places where they are wanting in height or section; but the work to be done in this respect is not very large, and is really of the nature of repairs.

(5) *Girisola channel.*—This will be dealt with fully lower down.

(6) *Surala reservoir.*—As has been explained above, the reservoir has a catchment of its own of 200 square miles.

From the enclosed statement of supplies received by the reservoir from its catchment for the years 1901–1902 to 1911–12 it will be seen that in the years 1901–1902, 1902–1903, 1905–1906, 1906–1907 and 1907–1908, it does not fill and that the total supply received from the catchment is comparatively small with reference to the total capacity of the tank and the yield in a good year. To remedy this it has been proposed to construct an anicut across the Johoro

at Gundribody and to take a supply channel from it, with a capacity of 263 cusecs, in the reservoir. It has been assumed that the Johoro will be in flood for 40 days in a year and that therefore it will deliver 910 million cubic feet a year into the reservoir. As has been explained above, it is only in years such as the five referred to above that the reservoir stands in need of extraneous help. In such years the yield from the catchment may be taken at about 1,500 million cubic feet. The yield of the Johoro for such years will therefore not exceed $\frac{1,500 \times 70}{200} = 525$ million cubic feet.

As the high floods capable of giving a full supply in the supply channel last only for about six or twelve hours (the catchment being very limited), it is unlikely that a supply channel carrying 263 cusecs could utilize more than 200 or 300 million cubic feet—if so much.

It is therefore to the Rushikulya that we must look for supplementing the supply in the reservoir. An anicut on this river and a supply channel (which will not be more than five or six miles long) will increase the efficiency of the reservoir many times and would give ample supply for all requirements. The discharge of the supply channel will have to be about 2,000 cusecs, so that the reservoir may be filled quickly and full advantage taken of floods of short duration.

The river-bed (Rushikulya) is + 300·00 within a distance of four miles from the Boradi weir. The country along which the channel will run presents no difficulties (except the crossing of the Bonthali nalla which drains an area of 25 square miles). It is believed that rock barriers exist both above and below Pippaloponka, but this has to be examined.

To make up for storage capacity already lost and to make full use of the available surplus in the Rushikulya that will be diverted by an anicut and channel as referred to above, it is proposed to raise the F.T.L. by 5 feet. The top of bund at present is 16 feet above the present F.T.L. at the deep portion and 13 feet at the flanks with a top width of 10 feet, front slopes of $1\frac{1}{2}$ to 1 and rear slopes of $1\frac{1}{2}$ to 1 up to a level of 22 feet below top, and 2 to 1 below, there being a rear berm (at the deep part) 27 feet wide where the rear slope is changed.* The present bund is quite substantial enough to stand this raising with only slight improvements as described below. The objection that the bund is so bad that it can never stand any raising of the F.T.L. is easily answered, for in that case the sooner the bund is made safe and sound the better. The bund in the first instance was no doubt built up with bad soil, but a great deal of this was removed and the bund re-made with good soil. Since its completion, it has stood all right. The leakage noticeable in rear is not more than is met with in any other reservoir of similar dimensions. The improvements necessary for the bund are—

* Vide Typical sections of bund attached.

(1) relaying the front revetment of the east dam for a length of 1,900 feet from Kuppula hill to a front slope of 2 to 1;

(2) raising the front revetment of the west dam and of the east dam from 4,300 feet from Kuppula hill towards the right flank.

25th March 1929]

There are two other questions connected with the reservoir which will also have to be dealt with, viz.:—

(1) the draining of the rear of the eastern bund, particularly the deep portion near the Kuppula hill and up to the turn near the Johoro; and

(2) the surplus arrangements.

With reference to the first item it may be remarked that the main drain in rear is being constantly choked up by the river with sand, as the outfall is at a point where the margin is shoaling up. Besides this the flood level of the river rises high and water in consequence backs up. There is, therefore, a certain amount of water always standing in rear of bund. It is not possible to remedy this without having recourse to the rather drastic and somewhat expensive measure of pumping out the water.

For disposal of surplus there are at present two weirs—the Padma 500 feet long at the right flank and the Boradi 1,200 feet long at the left. These weirs are capable of discharging the maximum flood which is calculated at 26,590 cusecs with a depth of 3 feet on crest. (It may be noted here that the bund was designed originally for a M.F.L. of 3½ feet over crest.) If the F.T.L. were to be raised by 5 feet as proposed above, it will be best to cut down the crest of the Padma weir by 3 feet and put up screw shutters 8 feet high over crest. At the Boradi weir, a subsidiary weir 3½ feet high may be built above (upstream side) the present one, with 1½ feet plank shutters on top. The latter may be of the bottom hinged type falling inwards. This would enable almost the whole of the surplus to be disposed off by the Padma weir, and this would be of great value in scouring out a large quantity of the silt that is now brought into the tank and deposited there. The work would thus help to prolong the life of the reservoir.

(7) *Janamilly anicut.*—The plank shutters over crest have worked satisfactorily here and nothing more is necessary. The head sluices, however, are awkwardly placed and are in the most favourable position possible for taking in a maximum of silt from the river. The remedies to be applied to this case are—

(1) a further raising of the sill by 1 foot;

(2) the construction of extra vents for discharge so that only the top water may be drawn; and

(3) the fitting up of new gearing with shutters in two tiers as has already been recommended for the Goomsur and Gulleri head sluices.

It is absolutely necessary in this case to insist on the head sluices being closed whenever the undersluices have to be worked, as all the silt disturbed by the scoring action of the undersluices will go straight into the head sluice.

(8) *Rushikulya canal.*—The original design of the canal provides for a F.S.L. of 6 feet with a discharge of 891 cusecs and a M.W.L. of 8 feet with a discharge of 1,465 cusecs. Besides the silt difficulty in the first reach, the banks in many places could not stand more than 7 feet safely. The amount of work to be done in raising and strengthening banks is not very much and would be treated as repairs. The banks at aqueduct approaches and at the 'sagarams' or tanks (when the canal is carried in single bank forming a tank on the upper side) require particular attention.

[25th March 1929

Among other points requiring attention are—

(1) an examination of the vent-ways of pipes and sluices with reference to ayacut; and

(2) the construction of permanent pipe sluices in places of temporary pipes, which are a source of great danger to the canal.

VII. The Godohallo and the Jayamangalam channel.—The Godohallo drains the Chinnakimidi and Peddakimidi maliahs and carries a very good supply. Its utilization for the improvement of supply in the Rushikulya canal and for extension of irrigation has long been discussed. At least two sites for reservoirs on the Godohallo were investigated in detail with capacities of 2,490 and 3,500 million cubic feet, respectively. The cost was estimated at about 16 lakhs of rupees. (*Note.*—These figures are taken from the correspondence in my office and I am not in possession of the correct figures, as the estimates are in the Chief Engineer's office and correct office copies are not available.)

On account of the prohibitive cost of construction as compared with the advantages realized, the scheme has been abandoned. At present the river supplies about 10,000 acres under the Jayamangalam channel, taking off from the Hinjili anicut besides an extent of about 2,000 acres belonging to the Chinnakimidi zamindar, which is supplied by the Rajakomma channel taking off from an anicut near Pattapur. A supply from the Jayamangalam channel is also given to the Koratholi Tampara which irrigates about 4,400 acres. This extent, however, may be omitted in considering the question of a supply from the Godohallo for the reason that the Koratholi Tampara provides storage and has a direct catchment of 8 square miles, while the Jayamangalam channel carries also the drainage from a catchment area of over 70 square miles.

The direct and indirect catchments of the Koratholi Tampara, along with its storage, are quite sufficient for the irrigation under it. The irrigation under the Rajakomma channel is now supplied to a large extent by the Rushikulya canal. As the river at the Hinjili anicut has a drainage area of 500 square miles, it will be seen that a catchment of 500 square miles is now devoted for the irrigation of 10,000 acres—please compare the catchments of the Rushikulya and Mahanadi above their anicuts and the irrigation under them—and that, in consequence, a very large volume of water is being run to waste, partly as surplus over the anicut and partly through the Jayamangalam channel. The latter for a great part of its length is really a large drain and is quite unsuited as an irrigation source. The channel carries—for the extent irrigated—an enormous supply from the river, besides drainage, and while the adjoining lands suffer by submersion in times of plenty, the lands under it are not commanded when the water-level falls (even though the supply is sufficient to meet all reasonable needs). To make this channel (which is in fact a large drain for the greatest portion of its length) efficient as an irrigation source, it will be necessary to construct outlets for disposal of drainage and regulators at intervals to raise water for irrigation.

It would certainly be much cheaper and in keeping with sound irrigation practice to let the channel alone to perform its functions as a drain and to transfer the irrigation at present under it to other sources.

The seventh distributary of the Rushikulya canal commands all the land lying between the Jayamangalam channel and the Rushikulya and its extension for this purpose could be carried out quite easily. The balance

25th March 1929]

could be transferred to the 9th, 13th and 14th distributaries without any extra cost. This arrangement would enable us, besides, to bring under irrigation about 5,000 acres of new lands lying between the river and the Jayamangalam channel. It would set the Godohallo free for utilization for supplying the Rushikulya canal, any balance left being still available for the Jayamangalam channel. At the site of the existing Pattapur anicut (or rather Palaspur anicut, as Pattapur is some distance away from the anicut), the river has a catchment area of 340 square miles. The existing anicut could be used and a short channel about two miles long would deliver the supply into the Rushikulya canal. The anicut is built on rock and the site is an ideal one for an anicut. The catchment area of the river between the Pattapur and Hinjili anicuts is about 160 square miles, so that it will be seen that the latter anicut will still continue to receive the drainage from a considerable unintercepted catchment. Besides this, the channel drains an area of 70 square miles, as has been noted above.

VIII. Summary of general principles on which the improvements proposed are based.—From what has been stated above, it will be seen that the principles on which the improvements proposed have been based and the objects which they are intended to achieve are—

(1) to make a larger use of the existing surplus in the rivers;

(2) to secure an increase of storage room, and more than this, to make the available capacity much more efficient, so that the reservoirs may fill not once, but many times in the season; and

(3) to harness for the purposes of the project two large rivers—the Godohallo and the Baguva which together will render available the discharge from a catchment area of about 700 square miles.

The details of works proposed to achieve these objects have already been referred to except those referring to the Baguva which will be described later on.

IX. Probable extents irrigable.—The storage available after the above improvements are carried out will be as follows:—

	M. C.FT.
Russellkonda reservoir—	
Present	2,149
Increase	321
Total ...	2,470
Surada reservoir—	
Present	1,430
Increase	570
Total ...	2,000
Grand total ...	4,470

As with the improvements proposed the reservoirs will generally fill several times in the season, it is expected that they would be left practically full at the end of September. On the assumption that there is a total failure of the north-east monsoon (which is not uncommon and which it is the

special function of the reservoirs to guard against), it will be seen that storage will be required for 45 days (i.e., from the 1st October to the 15th November). Taking the present irrigation under the system as 106,000 acres and supposing an increase of 50,000 acres + 10,000 under Jayamangalam, the storage required for 166,000 acres for 45 days with a canal head discharge at a duty of 100 will be 6,500 million cubic feet nearly. Of this quantity, the reservoirs will provide 4,470 million cubic feet. The balance of 2,030 million cubic feet will easily be provided by the rivers even in bad years as will be seen from the subjoined statement, which shows for the Goomsur and Janamilly anicuts the quantities available in the rivers during the months of October and November, exclusive of any contribution from the reservoirs :—

Year	Mahanadi discharges in million cubic feet.		Rushikulya discharges in million cubic feet.		Total mill. c. feet.
	Used.	Surplus.	Used.	Surplus.	
1901-02	850	230	440	1,100	2,620
1902-03	1,200	400	1,400	36	3,030
1904-05	2,000	3,700	2,400	4,600	12,700
1905-06	580	712	790	800	2,882

These figures *do not* include any water supplied by the reservoirs. 1904-05 is a good year, and has been included merely to show what might be expected in a good year. The other three are unfavourable and bad years.

Besides, the proposals contemplated the utilization of the discharges of the Godohallo and Baguva, which together will have a catchment area of about 700 square miles (above the anicuts proposed). The combined catchment of the Mahanadi and Rushikulya above the Goomsur and Janamilly anicuts is 1,720 square miles (inclusive of the catchments of the Russellkonda and Surada reservoirs). The extension of 50,000 acres proposed (or 60,000 including Jayamangalam) is, therefore, not unreasonable.

Location of the extension proposed.—With the information available at present, this could only be sketched roughly. The original project forecast of ayacut was 117,250 acres, and that now taken as the ultimate ayacut is 106,300 acres or cusecs. The reduction of 10,000 acres is in the ayacut of the 10th distributary or the Ichchapur channel. The area excluded has to be secured by extending the Ichchapur extension channel in contour above the Surla swamp and continuing it on to the Bahuda. As the lands will be situated from 60 to 70 miles away from the head of the canal, it is not advisable to include this area for the present—at all events not the whole of it.

It is believed that 10,000 acres of new lands could be got under the 7th, 10th, 11th, 15th and 16th distributaries, without having recourse to such violent measures as the draining of the Gouzu Tampara and the Surla swamp. The Rushikulya canal will also have to supply the 10,000 acres transferred from the Jayamangalam channel. The balance of 40,000 acres is proposed to be located under the Girisola—or left bank channel from the Goomsur anicut.

25th March 1929]

X. Girisola channel.—It is proposed to irrigate an extent of 40,000 acres under what is here called the Girisola channel. This will be divided into two reaches—the first one from the head at Goomsur anicut up to the Baguva, and the second from the Baguva to the Korakori nalla. The Baguva drains an area of 350 square miles and forms for a considerable length the boundary between the Government taluk of Goomsur and the Atagada zamindari. It is proposed to end the first reach of the channel on the borders of the Atagada zamindari, the water being dropped into one of the tributaries of the Baguva. It will be picked up again by means of an anicut across the river built some distance above where it enters the Rushikulya.

A channel taking off on the left bank above the anicut could be run up to the Korakori nalla. The first reach could irrigate from 10,000 to 12,000 acres, and the balance will be under the second reach. This arrangement of stopping the first reach at the Baguva and starting again lower down from an anicut at the site referred to has the following advantages:—

(1) A catchment area of 350 square miles will be available for the second reach, whereas for a crossing higher up the catchment may not be more than 200 square miles and even this is divided between three branches flowing some miles apart from one another.

(2) All the Government villages under the Purushottapur Deputy Tahsildar lying north of the Rushikulya will be benefited, besides many of the Government villages of Goomsur taluk (and only a comparatively small portion of zamindari lands); while in case the first reach was continued in contour beyond the Baguva, the majority of lands benefited would be zamindari.

XI. Cost of works proposed.—The following may be taken as a very approximate estimate of cost of the works proposed—

	Lakhs. RS.
I. Improvements to existing system—	
Gulleri anicut	0·4
Gulleri channel	0·5
Goomsur anicut	0·6
Russellkonda reservoir	0·1
Surada reservoir—	
(1) Rushikulya anicut and channel	1·5
(2) Improvements to reservoir	1·5
Godoballo channel	0·2
Extension of seventh and other distributaries ...	0·2
*II. New works (not connected with improvements)—	
Proposed Girisola channel (for 40,000 acres at Rs. 25 an acre)	10

*The costs of improvements to existing works and the excavation of the Girisola channel for 40,000 acres will be about 15 lakhs of rupees—including all charges.

Revenue.—It is difficult to forecast the net revenue realizable per acre accurately as old and new irrigation will be mixed up. In the present

[25th March 1929

Rushikulya area, the net revenue per acre of ayacut (old and new) is about Re. 1 per acre. Under the Girisola channel, however, the rate will be much higher.

For the Baguva reservoir project, the Collector forecasted a net revenue per acre of ayacut of about Rs. 2·25 (after the resettlement of 1913-14). Applying these rates we get the following results :—

	RS.
10,000 acres under Rushikulya canal at Re. 1 ...	10,000
40,000 acres under Girisola channel at Rs. 2·25...	90,000
Total	1,00,000

This will give a net return of 6·66 per cent on capital outlay.

It might, however, be marked that the works classed above as improvements will have to be carried out in any case sooner or later. If, therefore, the expenditure on this account is deducted in taking into account the net revenue, the return on capital outlay will be 9 per cent on the Girisola channel alone.

The latter channel will have also a considerable protective value. Using the formula—

$C = 20r + m.x.$ (page 33, Volume I, Irrigation Commission Report), when $m = 3$, $x = 6$ (as fixed by the Board of Revenue), $r = 2·25$, the value of C (the permissible capital outlay per acre irrigated) works out to Rs. 63 as against the actual cost of Rs. 25 noted above.

The works proposed are therefore likely to prove remunerative besides having a high protective value.

R. N. Arogyaswami Mudaliyar,
Executive Engineer, Ganjām Division.

12*th October* 1912.

TRUTH ALONE TRIUMPHS

Appendix I.

RAINFALL statement of 30 years at the stations, Berhampur and Russellkonda.

Station.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
June.															
Russellkonda ..	7·60	2·65	2·51	10·02	10·47	6·75	15·41	5·39	4·34	7·18	5·55	5·21	5·53	6·10	2·40
Berhampur	..	0·95	1·74	9·78	10·12	4·03	9·48	8·74	2·00	5·40	4·55	2·70	6·91	4·51	2·63
Total ..	7·60	3·60	4·25	19·80	20·59	10·78	24·89	14·13	6·64	12·58	10·10	7·91	12·44	10·61	5·03
Average ..	3·80	1·80	2·12	9·90	10·29	5·39	12·44	7·06	3·32	6·29	5·05	3·95	6·22	5·30	2·51
July.															
Russellkonda ..	4·58	7·63	9·19	14·06	8·21	10·90	11·55	7·74	5·61	10·15	6·64	5·07	12·02	8·09	5·55
Berhampur	..	8·01	7·99	6·83	6·24	6·64	9·63	6·76	9·20	9·42	6·46	..	7·61	6·34	3·27
Total ..	4·58	15·64	17·18	20·89	14·45	17·54	21·18	14·50	14·81	19·57	13·10	5·07	19·63	14·43	8·82
Average ..	2·29	7·82	8·59	10·44	7·22	8·77	10·59	7·25	7·40	9·73	6·55	2·53	9·81	7·21	4·41
August.															
Russellkonda ..	8·67	19·14	11·68	8·49	8·31	10·17	6·77	4·23	7·45	8·64	6·83	10·02	7·39	8·27	10·76
Berhampur	6·17	9·80	10·69	14·63	5·73	9·33	11·14	5·72	7·57	11·18	14·74	12·70	9·67	6·97	10·92
Total ..	14·84	28·94	22·37	23·12	14·07	19·50	17·91	9·95	15·02	19·82	21·57	22·72	17·06	15·24	21·68
Average ..	7·42	14·47	11·18	11·56	7·03	9·75	8·95	4·97	7·51	9·91	10·78	11·36	8·53	7·62	10·84

Rainfall Statement of 30 years at the stations, Berhampur and Russellkonda—*cont.*

Station.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
September.															
Russellkonda ..	4·60	8·59	7·16	7·70	9·91	10·82	13·14	15·70	6·20	11·73	8·12	6·30	5·74	11·51	12·90
Berhampur	8·21	7·00	6·69	8·24	6·43	5·07	3·95	9·11	5·92	10·49	4·50	..	4·70	6·11	5·27
Total ..	12·81	15.59	13·85	15·94	16·34	15·89	17·09	24·81	12·12	22·22	12·62	6·30	10·44	17·62	18·17
Average ..	6·40	7·79	6·92	7·97	8·17	7·94	8·54	12·40	6·02	11·11	6·31	3·15	5·22	8·81	9·08
October.															
Russellkonda ..	5·66	6·79	3·41	5·51	4·75	2·89	6·23	2·65	2·38	9·85	3·95	0·03	10·86	6·03	0·29
Berhampur	2·01	14·37	4·72	10·81	10·62	4·43	6·13	3·79	5·32	19·41	7·91	1·60	15·36	11·46	1·71
Total ..	7·67	21·16	8·13	16·32	15·37	7·32	12·11	6·44	7·70	29·26	11·86	1·63	26·22	17·49	2·00
Average ..	3·83	10·58	4·06	8·16	7·68	3·66	6·20	3·22	3·85	14·63	5·93	0·81	13·11	8·74	1·00
November.															
Russellkonda ..	..	5·87	4·81	0·97	0·15	2·13	5·94	0·14	2·87	5·08	1·35	2·14	10·46	0·40	1·13
Berhampur	0·04	7·96	4·17	4·47	1·45	3·78	3·70	0·13	7·51	8·94	1·13	4·94	13·68	6·45	2·21
Total ..	0·04	13·83	8·98	5·44	1·60	5·91	9·64	0·27	10·38	14·02	2·48	7·08	24·14	6·85	3·34
Average ..	0·02	6·91	4·49	2·72	0·80	2·95	4·82	0·13	5·19	7·01	1·24	3·54	12·07	3·42	1·67

Rainfall Statement of 30 years at the stations of Berhampur and Russellkonda—*cont.*

Station.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
June.															
Russellkonda ..	9·71	6·36	6·78	18·94	7·14	4·54	6·53	4·02	8·40	5·99	4·36	4·50	11·05	6·44	8·26
Berhampur	6·37	7·11	6·42	13·65	6·88	6·76	7·37	5·37	5·56	1·28	1·80	4·32	8·44	1·51	6·63
Total ..	16·08	13·47	13·20	32·59	14·02	11·30	13·90	9·39	13·96	7·27	6·16	8·82	19·49	7·95	14·89
Average ..	8·04	6·73	6·60	16·29	7·01	5·65	6·95	4·69	6·98	3·63	3·08	4·41	9·74	3·97	7·44
July.															
Russellkonda ..	11·47	12·12	14·02	13·78	7·73	6·71	11·10	11·06	5·81	7·50	10·47	11·52	6·24	6·13	8·78
Berhampur	6·29	9·56	12 39	5·49	8·04	7·83	9·75	9·01	3·30	8·22	10·12	14·95	4·61	5·67	7·73
Total ..	17 76	21·68	27·41	19·27	15·77	14·54	20·85	20·07	9·11	15·72	20·59	26·47	10·85	11·80	16·51
Average ..	8·88	10·84	13·70	9·63	7·88	7·27	10·42	10·03	4·55	7·86	10·29	13·23	5·42	5·90	8·25
August.															
Russellkonda ..	7·98	8·17	4·88	10·79	13·01	10·86	6·43	8·31	10·11	7·27	15·28	15·38	9·54	8·15	12·41
Berhampur	10·24	6·40	2·38	11·78	9·47	13·21	5·03	7·02	12·48	1·19	13·29	10 81	6·24	3·66	10 21
Total ..	18·22	14·57	7·26	22·57	22·48	24·07	11·46	15·33	22·59	8 46	28·57	26·19	15·78	11·81	22·62
Average ..	9·11	7·28	3·63	11·28	11·24	12·03	5·73	7·66	11·29	4·23	14·28	13·09	7·89	5·90	11·31

Rainfall Statement of 30 years at the stations of Berhampur and Russellkonda—*cont.*

Station.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
September.															
Russellkonda ..	13·21	11·31	5·35	6·61	4·83	12·79	7·83	3·29	10·58	4·32	5·69	12·50	8·86	6·33	9·14
Berhampur	10·34	10·33	5·70	4·46	2·58	14·87	4·61	3·34	7·37	12·81	3·81	6·31	9·30	12·19	4·96
Total ..	23·55	21·64	11·05	11·07	7·41	27·66	12·44	7·63	17·95	17·13	9·50	18·81	18·16	18·52	14·10
Average ..	11·77	10·82	5·52	5·53	3·70	13·33	6·22	3·81	8·97	8·56	4·75	9·40	9·08	9·26	7·05
October.															
Russellkonda ..	5·65	3·64	4·16	4·04	..	6·48	4·18	7·02	10·51	2·78	3·63	9·95	4·70	1·66	..
Berhampur	12·07	8·59	5·00	18·22	..	14·26	9·97	12·94	9·98	3·69	0·37	4·24	6·98	1·24	7·67
Total ..	17·72	12·23	9·16	22·26	..	20·74	14·15	19·96	20·49	6·47	4·00	14·19	11·68	2·90	7·67
Average ..	8·86	6·11	4·58	11·13	..	10·37	7·07	9·98	10·24	3·23	2·00	7·09	5·84	1·45	3·83
November.															
Russellkonda ..	0·23	0·40	3·30	0·23	0·10	1·81	..	..	0·42	2·42	0·16	6·45	..	0·24	0·28
Berhampur	0·06	3·73	3·06	0·05	..	4·35	0·50	..	..	10·36	0·03	8·07	..	..	0·05
Total ..	0·29	4·13	6·36	0·28	0·10	6·16	0·50	..	0·42	12·78	0·19	14·52	..	0·24	0·33
Average ..	0·14	2·06	3·18	0·14	0·05	3·08	0·25	..	0·21	6·39	0·09	7·26	..	0·12	0·16

Appendix II.

DISCHARGE in millions of cubic feet of Gulleri head works—head sluice.

Year.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.
1900–1901 ..	..	..	837	1,177	1,284	587	13	36	113	6	52	..
1901–1902 ..	21	..	..	..	65	242	118	50	..	..	..	..
1902–1903 ..	..	..	..	294	646	116	392	..	..	..	..	..
1903–1904 ..	..	8	73	744	845	333	..	..	..	..	..	..
1904–1905 ..	..	..	..	..	88	26	67	29	..	..	..	..
1905–1906 ..	..	..	..	..	440	639	146	3	..	..	..	..
1906–1907 ..	..	..	..	599	539	471	394	170	..	..	..	..
1907–1908 ..	72	..	78	374	287	280	57	..	..	..	..	..
1908–1909 ..	..	..	46	499	690	857	845	473	..	..	..	..
1909–1910 ..	..	..	328	869	15	42	28	60	..	..	..	..
1910–1911 ..	..	..	..	525	134	185	111	..	..	..	..	..
1911–1912 ..	..	..	..	23	194	382	80	81	5	..	..	..

Appendix III.

DISCHARGE in millions of cubic feet of Gumsoor head works—head sluice.

Year.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.
1900–1901 ..	..	..	..	210	985	839	467	689	1,694	646	152	191
1901–1902 ..	3,288	1,324	18	460	861	864	740	657	55	37	..	..
1902–1903 ..	..	..	..	325	1,228	1,084	1,176	1,515	516	493	..	..
1903–1904 ..	..	159	490	699	982	966	1,183	1,026	451	186	233	49
1904–1905 ..	474	..	5	..	549	482	1,295	888	2,344	..	339	346
1905–1906 ..	24	..	..	326	1,022	1,148	861	1,205	158	..	..	..
1906–1907 ..	..	..	..	165	860	1,081	864	433	..	95	..	..
1907–1908 ..	..	..	..	129	1,109	1,495	1,448	765	..	..	..	..
1908–1909 ..	..	..	..	713	1,186	1,274	1,292	1,233	459	..	155	..
1909–1910 ..	..	259	20	354	1,381	1,582	1,497	698	568	..	..	..
1910–1911 ..	114	..	..	373	811	937	592	434	7	..	..	..
1911–1912 ..	..	..	..	517	784	1,048	1,760	1,074	33	26	..	..

Appendix IV.

DISCHARGE in millions of cubic feet of Janamilly head works—head sluice.

Year.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.
1900–1901 ..	703	509	..	309	784	914	874	866	80	61	279	44
1901–1902 ..	99	..	62	661	1,281	..	959	859	130	136	124	170
1902–1903 ..	540	24	..	524	1,443	1,527	1,285	892	..	117	57	165
1903–1904 ..	68	320	379	1,340	1,684	1,068	1,878	928	138	212	399	427
1904–1905 ..	607	603	664	1,020	1,347	684	2,653	1,783	613	91	194	490
1905–1906 ..	13	31	75	412	1,279	708	1,117	1,499	197	3	..	..
1906–1907 ..	..	..	..	409	1,517	962	1,746	550	436	519	..	328
1907–1908 ..	288	49	387	814	952	1,738	1,578	525	332	209	..	..
1908–1909 ..	..	..	72	685	1,571	1,507	1,744	1,209	623	195	..	..
1909–1910 ..	242	440	..	657	1,359	1,325	1,882	1,413	699	..	..	..
1910–1911 ..	605	..	97	1,143	1,094	2,240	745	894	387	297	9	..
1911–1912 ..	..	..	267	1,424	2,423	1,378	1,664	1,949	4	..	518	..

Appendix V.

STATEMENT showing the gauge readings and capacity of Russellkonda reservoir on the 1st and 15th of every month during the years 1901 to 1911.

—	Date.	April.		May.		June.		July.		August.		September.	
		Gauge.	Capacity.	Gauge.	Capacity.	Gauge.	Capacity.	Gauge.	Capacity.	Gauge.	Capacity.	Gauge.	Capacity.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1901–1902	1	41·93	1,764	40·85	1,671	40·45	1,634	40·28	1,616	40·69	1,652	40·69	1,652
	15	41·00	1,680	40·83	1,662	40·26	1,616	40·25	1,616	41·11	1,689	35·50	1,223
1902–1903	1	23·72	526	23·57	521	23·09	499	23·20	504	29·55	513	42·50	1,822
	15	23·48	517	23·29	508	23·19	504	25·20	585	31·60	954	43·34	1,900
1903–1904	1	6·18	63	6·50	68	5·50	54	7·98	90	24·40	557	38·80	1,485
	15	6·16	63	5·81	58	6·90	73	17·80	306	30·80	903	43·58	1,931
1904–1905	1	43·96	1,970	42·83	1,851	42·35	1,812	43·50	1,920	43·80	1,951	45·30	2,106
	15	43·44	1,910	42·55	1,832	42·38	1,812	44·08	1,981	44·40	2,012	45·80	2,159
1905–1906	1	40·90	1,671	40·80	1,662	40·55	1,643	40·65	1,652	40·94	1,671	43·24	1,890
	15	40·90	1,671	40·68	1,652	40·44	1,625	41·21	1,698	41·15	1,698	44·10	1,981
1906–1907	1	17·22	288	16·65	274	16·39	266	18·32	321	29·00	796	37·90	1,416
	15	16·97	282	16·43	266	16·88	279	21·80	446	33·25	1,066	41·00	1,680
1907–1908	1	41·43	1,717	41·62	1,736	41·35	1,717	41·70	1,745	44·10	1,981	44·43	2,012
	15	41·20	1,698	41·32	1,708	41·30	1,708	41·85	1,764	44·50	2,022	45·80	2,159
1908–1909	1	19·80	371	19·50	360	19·30	354	22·25	466	26·30	649	35·30	1,208
	15	19·65	367	19·45	360	19·30	354	24·00	539	30·20	867	38·20	1,443
1909–1910	1	37·55	1,389	37·75	1,407	37·45	1,381	40·20	1,607	45·70	2,149	45·90	2,170
	15	37·70	1,398	37·60	1,389	38·65	1,477	42·40	1,812	45·75	2,159	45·65	2,149
1910–1911	1	35·60	1,230	34·70	1,164	34·30	1,136	37·75	1,407	45·10	2,085	45·80	2,157
	15	35·35	1,215	34·50	1,150	35·30	1,208	41·90	1,764	45·45	2,127	45·90	2,170

Statement showing the gauge readings and capacity of Russellkonda reservoir on the 1st and 15th of every month during the years 1901 to 1911—*cont.*

—	Date.	October.		November.		December.		January.		February.		March.	
		Gauge. (15)	Capacity. (16)	Gauge. (17)	Capacity. (18)	Gauge. (19)	Capacity. (20)	Gauge. (21)	Capacity. (22)	Gauge. (23)	Capacity. (24)	Gauge. (25)	Capacity. (26)
1901–1902	1	32·60	1,019	30·50	885	25·94	629	25·30	600	25·18	595	24·36	557
	15	32·45	1,013	25·70	619	25·66	619	25·16	595	24·82	576	23·93	535
1902–1903	1	43·18	1 890	35·25	1,208	21·40	430	10·69	139	8·97	107	7·58	84
	15	41·45	1,726	28·00	739	10·70	139	9·90	107	7·59	84	6·20	63
1903–1904	1	45·45	2,127	45·25	2,106	45·70	2,149	45·18	2,095	44·87	2,064	44·55	2,033
	15	45·17	2,095	45·50	2,127	45·45	2,147	45 05	2,085	44·64	2,033	44·38	2,012
1904–1905	1	44·70	2,043	43·56	1,931	43·25	1,900	42·85	1,861	42·85	1,861	42·40	1,812
	15	43·75	1,951	43·15	1,890	43·00	1,870	42·68	1,841	42·65	1,841	41·80	1,755
1905–1906	1	45·10	2,085	39·60	1,554	28·79	728	18·06	315	17·79	306	17·31	291
	15	43·62	1,931	32·95	1,045	19·25	354	17·99	311	17·46	297	17·08	285
1906–1907	1	43·75	1,951	42·30	1,802	42·50	1,822	42·18	1,793	41·90	1,764	41·50	1,726
	15	44·30	2,002	42·70	1,841	42·28	1,802	42·12	1,783	41 70	1,745	41·30	1,708
1907–1908	1	44·90	2,064	30·70	897	20·20	411	20·10	381	20·85	411	20·25	389
	15	40·50	1,634	20·30	389	20·90	411	20·90	411	20·80	407	20·10	381
1908–1909	1	42·45	1,822	44·50	2,022	39·30	1,528	38·85	1,494	38·65	1,477	38·35	1,452
	15	45·45	2,138	39·90	1,580	39·10	1,511	38·80	1,485	38·60	1,468	38·15	1,435
1909–1910	1	45·10	2,085	37·45	1,381	36·80	1,322	36·72	1,314	36·45	1,299	36·10	1,268
	15	43·50	1,920	36·55	1,337	36·80	1,322	36·54	1,299	36·40	1,290	35·80	1,245
1910–1911	1	46·05	2,180	45·61	2,138	45·10	2,085	44·90	2,064	44·60	2,033	44·20	1,991
	15	45·75	2,159	45·22	2,095	44·96	2,074	44·78	2,053	44 40	2,012	44·05	1,981

Appendix VI.

STATEMENT showing the gauge readings and capacity of Surada reservoir on the 1st and 15th of every month during the years 1901 to 1911.

Year.	Date.	April.		May.		June.		July.		August.		September.	
		Gauge.	Capacity.	Gauge.	Capacity.	Gauge.	Capacity.	Gauge.	Capacity.	Gauge.	Capacity.	Gauge.	Capacity.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1901–1902	1	21·66	856	21·40	883	21·10	810	21·07	810	24·90	1,122	25·80	1,207
	15	21·43	833	21·10	810	20·98	802	22·06	879	26·50	1,275	23·20	975
1902–1903	1	20·40	758	15·10	451	14·90	443	14·60	429	15·42	463	27·00	1,325
	15	16·45	514	14·90	443	14·72	434	15·20	455	17·40	564	27·40	1,367
1903–1904	1	8·10	186	7·02	153	3·80	71	7·30	162	16·50	514	27·10	1,336
	15	7·35	165	5·30	107	5·97	125	11·90	318	19·80	715	26·25	1,255
1904–1905	1	25·30	1,159	22·83	943	21·07	810	21·07	810	19·70	709	16·88	535
	15	24·91	1,122	21·62	853	20·00	729	21·00	802	18·80	648	29·20	1,557
1905–1906	1	18·99	660	19·09	668	19·09	668	18·74	642	19·81	715	19·93	722
	15	19·30	681	19·02	661	18·87	655	18·85	655	21·01	802	18·36	623
1906–1907	1	3·18	58	2·65	48	1·96	33	5·65	117	12·90	358	13·90	399
	15	3·03	54	2·22	40	5·80	120	9·40	228	3·40	63	15·50	468
1907–1908	1	9·07	218	10·46	266	10·22	256	11·60	307	18·42	623	18·71	642
	15	8·90	212	10·21	256	10·32	259	15·05	451	17·32	558	19·80	715
1908–1909	1	6·48	139	6·00	125	5·56	115	6·95	153	13·00	362	22·28	903
	15	6·30	134	5·90	123	5·31	107	8·18	186	19·50	695	28·14	1,441
1909–1910	1	13·16	370	13·68	391	12·73	350	16·60	520	24·20	1,060	27·50	1,378
	15	13·34	374	13·13	366	14·75	438	21·25	825	25·40	1,168	28·20	1,452
1910–1911	1	14·65	434	13·68	391	13·72	391	20·90	795	23·80	1,026	28·32	1,462
	15	14·22	412	13·45	381	18·82	648	21·18	810	27·54	1,378	28·25	1,462

Statement showing the gauge readings and capacity of Surada reservoir on the 1st and 15th of every month during the years 1901 to 1911—*cont.*

Year.	Date.	October.		November.		December.		January.		February.		March.	
		Gauge (15)	Capacity. (16)	Gauge. (17)	Capacity. (18)	Gauge. (19)	Capacity. (20)	Gauge. (21)	Capacity. (22)	Gauge. (23)	Capacity. (24)	Gauge. (25)	Capacity. (26)
1901-1902	1	21·44	833	23·16	975	25·30	1,159	25·28	1,159	24·84	1,113	23·26	984
	15	22·80	941	18·40	623	25·41	1,169	25·07	1,141	24·67	1,104	23·06	967
1902-1903	1	25·92	1,216	17·91	592	16·84	530	16·33	504	16·09	493	13·89	399
	15	18·12	604	17·00	540	16·46	514	16·23	499	13·91	399	11·73	311
1903-1904	1	28·60	1,494	27·05	1,325	28·30	1,462	28·22	1,452	27·78	1,410	27·18	1,346
	15	27·50	1,379	27·85	1,420	28·40	1,473	28·08	1,451	27·62	1,388	26·92	1,315
1904-1905	1	28·00	1,431	28·12	1,441	19·83	715	19·62	702	19·28	681	19·00	661
	15	22·20	895	22·68	935	19·79	715	19·46	695	19·13	668	19·07	668
1905-1906	1	26·25	1,255	21·55	841	4·95	99	4·56	90	2·22	38	3·60	67
	15	27·14	1,336	15·18	455	4·80	95	4·34	83	1·30	21	3·40	63
1906-1907	1	21·44	833	10·80	277	15·19	455	15·25	459	14·96	446	13·89	399
	15	14·50	425	14·89	443	15·08	451	15·18	455	14·79	438	11·90	318
1907-1908	1	21·00	802	8·08	186	7·79	177	7·49	168	7·35	165	6·82	148
	15	10·20	256	7·76	177	7·82	177	7·56	171	7·22	159	6·60	142
1908-1909	1	26·25	1,255	21·70	856	14·58	429	14·25	416	13·93	399	13·72	391
	15	23·22	975	14·78	438	14·38	421	13·97	403	13·86	399	13·46	384
1909-1910	1	28·08	1,441	13·30	374	12·90	358	16·11	493	15·85	484	15·18	455
	15	22·70	935	13·26	374	14·68	434	16·01	488	15·66	476	15·07	451
1910-1911	1	28·32	1,462	28·42	1,473	28·03	1,431	27·76	1,410	27·35	1,367	26·80	1,305
	15	28·26	1,462	28·21	1,452	27·96	1,430	27·59	1,388	27·05	1,335	26·68	1,285

[25th March 1929

Appendix VII.

STATEMENT showing the discharge of Godahallo river at Hinjili anicut for ten years.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1901.	..	..	..	..	..	..	256·8	307·1	653·92	592·30	3,029·86	436·5
1902.	276·5	33·2	..	..	..	..	155·2	1,609·37	1,700·09	149·1	159·9	137·9
1903.	46·9	..	..	..	..	95·8	1,029·9	2,571·22	5,263·32	2,041·00	719·77	400·87
1904.	251·9	37·2	..	..	..	..	276·67	253·06	2,507·36	3,343·40	116·7	86·9
1905.	..	.	..	..	..	..	..	200·8	3,527·75	484 87	224·1	140·7
1906.	..	..	..	..	..	29·2	98·44	819·13	2,003·38	1,367·55	717·50	126·3
1907.	73·9	..	..	..	..	222·75	335·37	220·90	799·92	201·3	171·6	158·1
1908.	..	..	..	..	..	..	79·5	518·98	2,415·73	1,334·74	708·5	657·7
1909.	190·8	..	..	306·2	226·8	846·20	270·69	182·88	1,085·91	345·53	415·5	1,465·14
1910.	..	..	..	..	..	959·03	518·41	3,145·22	468·82	4,505·53	242·59	262·3

Appendix VIII.

GULLERI head works—Surplus in river.

Year.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.
1900–1901	13	154	476	437	2,078	2,830	4,174	92	..	..	2	..
1901–1902	11	..	..	416	764	99	20	..	..	..	..	..
1902–1903	..	..	62	258	1,991	1,450	46	..	..	..	..	..
1903–1904	..	..	1	854	1,588	2,180	934	1,486	186	122	..	..
1904–1905	..	..	173	787	453	1,167	472	138	238	37	..	24
1905–1906	11	21	..	126	189	53	25	..	..	..	118	5
1906–1907	..	..	..	753	399	197	13	..	..	..	..	..
1907–1908	26	..	1	732	1,376	839	..	..	..	..	..	..
1908–1909	..	..	6	220	1,722	801	964	..	..	..	..	..
1909–1910	319	54	542	202	1,580	434	26	60	..	..	..	..
1910–1911	381	486	738	445	1,168	712	..	..	..	..	..	..
1911–1912	..	..	792	626	3	1,315	386	..	..	..	..	..
Total ..	..	..	2,791	5,856	13,301	12,077	..	..	..	..	..	..
Average ..	..	..	232	488	1,183	1,006	..	..	..	..	..	..

25th March 1929]

Appendix IX.

JANAMILLY head works—Surplus in river.

Year.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.
1900-1901.	122	344	846	642	7,382	10,084	9,899	2,118	139	159	80	..
1901-1902.	424	655	319	1,962	734	..	466	721	274	..	22	..
1902-1903	98	..	35	206	3,414	1,794	28	..	..	..	55	77
1903-1904.	..	..	236	2,485	2,189	8,762	4,498	1,402	923	133	..	..
1904-1905.	..	..	162	817	2,014	5,293	3,985	601	37	67	152	187
1905-1906.	232	312	..	696	192	1,901	686	170	108	60	156	12
1906-1907.	..	3	334	363	695	826	201	102	80	51	70	29
1907-1908.	23	..	12	1,841	776	496	25	..	..	..	..	..
1908-1909.	..	23	541	729	2,495	4,064	2,434	14	11	..	44	..
1909-1910.	7	155	1,928	1,613	454	1,747	7	45	81	458	82	..
1910-1911.	..	88	1,633	1,154	1,421	323	7,335	886	849	24	..	8
1911-1912.	..	260	3,384	243	9	4,714	1,373	57	909	104	216	20
Total ..	..	..	9,430	12,251	21,775	40,004	30,887	6,116	..	..	..	..
Average..	..	..	785	1,104	1,814	3,333	2,574	595	..	..	..	..

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TRUTH ALONE TRIUMPHS

Appendix X.

GUMSUR Head Works—Surplus in river.

Year.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.
1901-1902	..	53	..	1,112	2,230	335	152	82	..	..	13	..
1902-1903	287	..	540	1,780	7,520	2,540	390	15	..	..	52	59
1903-1904	..	..	201	4,560	6,995	9,757	7,249	9,442	1,663	104	..	..
1904-1905	..	..	702	..	5,389	8,948	3,643	90	..	..	..	11
1905-1906	320	..	..	1,026	2,386	1,280	712	..	..	..	98	122
1906-1907	..	..	904	3,442	4,688	5,262	535	2,108	..	..	..	..
1907-1908	26	..	6	4,332	5,601	3,934	33	..	..	..	..	..
1908-1909	..	..	525	1,399	7,264	5,362	3,554	25	..	768	..	..
1909-1910	433	..	2,537	2,729	3,578	1,140	92	..	56	77	..	..
1910-1911	..	..	886	4,505	3,584	5,163	9,892	1,033	289	11	..	..
1911-1912	..	..	2,297	505	851	6,906	2,696	130	178	17	186	..
Total ..	..	..	8,658	25,390	50,086	51,027	28,948	..	..	..	..	..
Average ..	..	..	721	2,115	4,173	4,252	2,412	..	..	..	..	..

TRUTH ALONE TRIUMPHS

Appendix XI.

Statement showing the quantity of water received from the catchment to Surada Reservoir from 1902—1912 in millions of cubic feet.

Name of month.	1902–1903. Quantity of water received in millions of cubic feet.	1903–1904. Quantity of water received in millions of cubic feet.	1904–1905. Quantity of water received in millions of cubic feet.	1905–1906. Quantity of water received in millions of cubic feet.	1906–1907. Quantity of water received in millions of cubic feet.	1907–1908. Quantity of water received in millions of cubic feet.	1908–1909. Quantity of water received in millions of cubic feet.	1909–1910. Quantity of water received in millions of cubic feet.	1910–1911. Quantity of water received in millions of cubic feet.	1911–1912. Quantity of water received in millions of cubic feet.
April	15·72	10·18	— 24·92	56·33	5·52	70·71	6·50	52·12	42·23	15·10
May	29·04	19·75	3·75	49·05	— 0·50	16·57	9·86	2·52	31·53	13·63
June	8·98	100·93	121·35	6·34	95·43	65·22	218·61	187·13	433·28	679·72
July	56·68	285·21	99·30	93·12	244·61	377·23	44·35	531·60	244·78	15·94
August	780·08	1,094·33	551·82	160·49	565·54	207·86	540·06	342·07	1,144·23	5·60
September	398·56	2,809·29	1,438·04	731·30	440·38	379·01	2,035·93	334·82	656·11	2,299·84
October	— 54·17	1,147·81	915·55	222·62	376·64	— 2·77	1,192·34	— 6·40	1,935·87	429·51
November	13·21	162·49	73·85	12·18	198·58	6·34	31·75	— 4·55	206·18	— 33·13
December	7·46	1,909·46	599·54	81·02	26·93	8·07	2·70	157·62	32·60	50·35
January	14·96	68·29	12·63	6·87	10·69	11·85	9·37	14·06	— 0·28	6·26
February	32·02	25·57	29·38	7·39	15·62	55·79	23·72	15·19	15·07	120·20
March	32·37	— 78·17	49·5	8·20	154·03	12·12	14·15	14·31	35·06	17·95

Note.—The monthly figures have been arrived at by the formula—supply received during the month = (quantity in reservoir at end of month) — (quantity at beginning of month) + (quantity discharged by sluices and weirs) + (quantity lost by evaporation). The quantities in the reservoir at the beginning and end of each month are arrived from the known capacities of the reservoir corresponding to the gauge readings.

The quantity discharged by sluices and weirs are worked out by formula from data available from the gauge registers. The quantity lost by evaporation is taken a certain depth lost at mean level of water during the month. The depths assumed as lost are as follows :—

For April, May, February and March, 9 inches.
For June, July, November, December and January, 6 inches.
For August, September and October, 3 inches.

The irrigation figures represent losses due to leakage and other unaccounted sources and in some cases probably to under-estimation of evaporative losses. The above table and the gauge readings of the reservoir might be made the basis of useful study in many directions.

[25th March 1929

II

Chief Engineer's Memorandum, Dis. No. 479, dated 4th March 1913.

With reference to the letter from the Superintending Engineer, I Circle, forwarding a note by Mr. Arogyaswami Mudaliyar on the Rushikulya system, the Chief Engineer for Irrigation has the honour to make the following remarks.

2. While recognizing that the reservoirs are most generally used to supplement deficiencies in the north-east monsoon, it should be clearly understood that their function is to compensate for deficiencies in rainfall and river supplies at any time after the south-west monsoon has set in and that this should be taken into consideration in making proposals in future.

3. *Russellkonda reservoir.*—The possibility of raising the F.T.L. of this reservoir by 3 feet is accepted, but in the present state of the Mahanadi canal it would be useless to do so. Until such time as the canal can be made to carry at least the theoretical supply allotted to it in the project estimates, viz., 471 cusecs, it is considered premature to think of increasing the capacity of the reservoir. When this is done, it will probably be advisable to increase the supply through the Gulleri channel if it can be done at a reasonable cost. The information afforded in Mr. Arogyaswami Mudaliyar's note is too meagre to permit of any conclusions being drawn in this respect.

4. The Chief Engineer for Irrigation is strongly of opinion that it would be unsafe to raise the F.T.L. of the Surada reservoir which has given so much cause for apprehension in the past.

5. With regard to the best method of increasing the supply into the Surada reservoir, there is no objection to the Superintending Engineer investigating the possibility of a channel from the Rushikulya river which would undoubtedly give a more assured supply. It may be stated *passim* that the Chief Engineer for Irrigation does not accept Mr. Arogyaswami Mudaliyar's calculations regarding the rate of silting of the Surada reservoir as even approximately correct and he believes that the reason why the whole contents of the reservoir cannot reach the sluice is very different from that given by the Executive Engineer—*vide* paragraph 5 of Inspection Notes printed with G.O. No. 566 I., dated 12th December 1912.

6. The Chief Engineer for Irrigation has already in paragraph 4 of the same notes given instructions for the completion of the estimate for the Girisola channel and these should be adhered to. He is not prepared to consider the proposals of the Executive Engineer for an extension depending mainly on the supply from the Baguva river until it is shown that water is available. In a bad year it is believed that the flow in the Baguva river during October and November (the period of greatest demand on the reservoirs) would be practically *nil* and all supplies would have to be given from the Russellkonda reservoir. If the Superintending Engineer finds that there is a possibility of doing this, there is no objection to his designing the banks of the Girisola channel so that it can be subsequently widened for the extension now proposed by the Executive Engineer.

7. The Chief Engineer for Irrigation has in the last paragraph of his inspection notes dealt with the proposed alterations under the Jayamangalam channel and the instructions there given should be adhered to.

25th March 1929]

8. The above deals with the proposed extensions. With regard to the improvements necessary to the existing system, the Chief Engineer for Irrigation has given a detailed programme of what is required and sees no reason to modify those instructions except as regards the head sluice to the Mahanadi canal. In his inspection notes it was directed that two tiers of shutters should be provided to the head sluice. The Superintending Engineer considers that with the construction of a wall to reverse the current, this will be unnecessary. There is no objection to the result of this experiment being ascertained before the existing shutters are altered, but should that experiment not prove as satisfactory as the Superintending Engineer hopes, the shutters should be divided as proposed by the Executive Engineer.

9. In conclusion, the Chief Engineer for Irrigation considers that it is most important to put the existing system in thorough order before extensions are undertaken, but as soon as the improvements now ordered are sufficiently advanced to admit of the Executive Engineer taking up fresh investigation, he should at once do so beginning with those schemes which have a reasonable prospect of being remunerative.

10. With regard to the Executive Engineer's suggestion that the Godohallo project should be reinvestigated as a famine-relief work, the undersigned is not prepared to accept this proposal. The project would even in its reduced form be very costly. The work would have to be well executed, and it is hoped that no famine will occur of sufficient duration to necessitate even a title of the necessary work being carried out by famine labour. This idea may therefore be given up.

H. E. CLERK,
Chief Engineer for Irrigation.

III

INSPECTION NOTES OF THE HON'BLE MR. H. E. CLERK, CHIEF ENGINEER FOR IRRIGATION, DURING NOVEMBER 1912.

RUSHIKULYA SYSTEM 10TH TO 21ST NOVEMBER.

Russellkonda reservoir.—The bund is in good order and there is but little leakage on the date of my inspection with water at + 43·7 or 1·8 below F.T.L. There are good drains leading from the toe of the bund but the notches are not sufficiently high above the floor and should be replaced so that the discharge can be accurately measured. There is a good deal of swampy land in rear which is due not to leakage from the bund but to springs from the hill below the left flank. This swamp should be drained as far as possible to the inlet and outlet through the Borasingi distributary.

The head sluice shutters work very stiffly, mainly, I believe, owing to defective design, but the gearing has not been examined for a long time and an early opportunity should be taken of taking the bearings down.

Surplus escape has a leading channel and drop over a road dam, but there is no well defined surplus channel after about 400 feet and complaints have been received from the owners of lands over which the surplus passes. A proposal to acquire land for a surplus channel at considerable cost was made, but in view of the very few occasions on which this escape need pass

water if the head sluice is properly made use of, I refused to recommend the proposal for sanction. I now find that the ryots have erected a bund of considerable strength and said to be about 4 feet higher than the crest of the escape to protect their fields. This bund is said to breach whenever the tank surpluses heavily at this escape. It has come into action more frequently than usual of recent years because the correct procedure of passing surplus through the head sluice in the first instance had for some reason been given up. It has now been reverted to. It is necessary to consider the surplus arrangements of the tank in some detail. The maximum surplus discharge appears to have been designed with a co-efficient of 500 in Ryves' formula at the length of the escape fixed accordingly. I find however that the maximum flood which occurred at the Gumsur anicut in October 1900 amounted to about 90,000 cusecs giving a co-efficient from the whole catchment area of about 1,000. Applying this co-efficient to the Rushikulya reservoir with a catchment area of 25 square miles, the flood discharge would be 8,550 cusecs instead of 4,300 given in the completion report. It is however permissible with so large a reservoir as this to take into account the moderating effect of the layer between F.T.L. and M.W.L. The superficial area at F.T.L. is stated to be 1,357 millions cubic feet and the capacity between F.T.L. and M.W.L. may roughly be put at 4,500 millions cubic feet. This is equivalent to a run-off of $\frac{4,500}{2{\cdot}32 \times 25}$ = 7·7 inches from the catchment.

The discharge of the head sluice which should always be used for surplusing is limited by the capacity of the leading channel and may be put down as 1,000 cusecs 86 millions cubic feet in 24 hours, but with the aid of this the surplus weir should never come into action except in very heavy floods. Such a flood must have occurred in October 1900 when on the 6th of that month 8·35 inches fell at Gulleri anicut and 7′ 14″ at Russellkonda. On this occasion the only effect of the flood was to raise the water level by about 1′ 6″ and as the water was nearly that depth below F.T.L. the surplus over the weir was insignificant. In these circumstances, I think a reasonable compromise can be come to with the ryots who should not be allowed to raise their bund above crest level of the weir and road dam while a channel to pass off as much water as possible along the contour channel should be made.

2. *Goomsur anicut.*—This is founded on wells 9′ deep; it has a body wall 12·20 feet high above top of wells and has an overfall of 7·20 feet on to a concrete apron 4′ thick. Below this is a dry stone apron 50′ long and a dry stone talus 80′ long. The concrete apron which is floored with 6″ Portland cement for first 10′ from body wall stands very well and seems to require but little repair. I saw no springs in the dry stone apron which one would expect to find with water nearly level with the turf bund 2″ above crest of anicut, but there are, I believe, a few here and there. The head sluice and scouring sluices are in good order but the gearing of the latter works very stiffly and there is a great deal of leakage under and over the shutters which should be stopped. The head sluice sill was originally at + 184 or one foot above sill of scouring sluices. It was afterwards raised to + 187·00 and subsequently cut down to + 185·50 at which level it now is. Owing to the silting in the Mahanadhi canal, various expedients have been tried to diminish the entrance of sand into the canal. Last year a sand bag barrier was constructed in front of the head sluice with top level at + 188·50 or

25th March 1929]

1·50′ below crest of the anicut. This does not seem to have had any appreciable effect as the bags were rotten and burst and the groyne was swept away. Soundings and gaugings are now being taken with F.S.L. in the canal and when these are known and compared with the bed levels taken in February 1911 and those taken in March of last year we shall be able to form a better idea of what bed fall we are likely to be able to maintain in future.

Whatever decision may be come to in this respect, it is important to keep the bed level above the anicut as low as possible and for this purpose I would erect two shutters 30′ wide and 6′ deep just beyond the present scouring sluices They should have their cills 4′ below the present crest of the anicut It is probable that the addition of one or two wells above the line of the existing ones will be all that is required. Designs for this will be drawn out in the office of the Chief Engineer for Irrigation and sent to the Superintending Engineer to estimate. Other works which are required are dividing the present shutters of the head sluice into two so that the upper shutter can be lifted independently of the lower one and improving the gearing of the scouring sluices. A puddle apron protected with dry stone is required upstream, but this may be carried when the crest is raised permanently.

At present a turf bund is erected on the crest of the anicut and answers its purpose well enough unless it is necessary to make it early in the season. The body wall of the anicut is far too thin and I cannot recommend its being raised solid until I can decide how it should be strengthened. This proposal may therefore lie over for the present. The Superintending Engineer proposes certain experiments to turn the current upstream before entering the head sluice. I have no objection to these being made. They will not be costly and may possibly be effective. The Superintending Engineer can sanction them himself from maintenance.

3. *Mahanadi canal.*—There is now about two feet of sand above the sill of head sluice or 3½′ above original bed level. When levels were last taken, the bed slope for the first mile was about 2′ per mile and for the second about 1·5′ per mile. I hope that by the erection of two wide shutters on anicut with cills at 186 we may be able to keep the bed of the river above the head sluice somewhere near that level and consequently lower than the bed level in the canal, but I do not anticipate that bed fall will be reduced below something between 1·5′ and 2′ a mile. At 0·6 is an aqueduct and it would be well to fit scouring sluices into the downstream wall of this. I am not helpful of this doing much good; but it may be tried, as the expense will not be great. At 1·6 there is an aqueduct which has entirely silted up and in June 1911 breaches in the canal were caused by a local flood topping the bank entering the canal and breaching it some 18 miles lower down. The Superintending Engineer is taking steps to remedy this. If nothing permanent is done before next June, the vents should be cleared. Other aqueducts in this canal are more or less silted up and should receive attention. All vegetation should be removed for 100′ on upstream side and where silted on the downstream side cuts should be made to assist the water to scour away the shoals.

The Nimina cutting in about 12th mile was inspected. It now seems in good order and not to give trouble. The drains have been cleared out recently. They will want frequent inspection.

[25th March 1929

4. *Girisola channel.*—This is a proposal to take off a channel from the left flank of Gumsur anicut, and has been under consideration since 1902. In that year an estimate amounting to Rs. 15,500 was submitted by the Superintending Engineer, I Circle, for irrigating 4,000 acres under this channel. This estimate was returned by the Chief Engineer for Irrigation for further information. In June 1904 the Executive Engineer reported that he had found a better line whereby 11,000 acres could be commanded, that the area actually commanded by the first proposal was only 2,000 acres, and that an entirely new investigation had been made and was approaching completion. In March 1905 the Superintending Engineer, I Circle, inspected the channel and gave further instructions which necessitated, the realignment of the channel and fresh levels had to be taken. In January 1906 the estimates were submitted to the Superintending Engineer who required further information and alteration in some of the designs. This involved a good deal of extra levelling and various alterations were proposed; as a result although the estimate has been submitted once more to the Superintending Engineer, nothing definite has been decided on. The great delay which has taken place may be attributed (1) to changes of officers, (2) to the fact that all the work was done by the existing staff who were probably fully employed especially during the closure of the canals when much other work has to be done. The design is an exceedingly difficult one and every officer who has undertaken the task has had to study the problem anew each time.

It may in the first place be stated that there is a small head sluice with vent 4′ × 4′ and cill level at + 187·50. For the first four miles land for the channel was acquired in 1894 and charged to the project estimates. This fact should not be lost sight of in fixing the final alignment of the channel though there is a little doubt that, if it is desirable to move the line higher up the slope, the ryots will not object to change lands.

The Executive Engineer has asked for orders on two points with regard to this channel. (1) What duty should be adopted. Mr. Venkatarama Ayyar who last submitted this estimate started with an assumed duty of 150 at the heads of distributaries, added 8 cubic feet per million square feet of wetted perimeter and arrived at discharge at the head and a consequential duty for the canal. In this I think he was wrong because the evidence on which a duty of 150 can be worked to at the head of distributaries is of the slightest and because the allowance of 8 cusecs per million cubic feet of W.P. is in my opinion altogether excessive. We have in evidence of this the Mahanadi canal which passes through precisely similar soil and has staunched itself very thoroughly with silt. I do not think therefore that the losses will be appreciable. I would put them at the outside at 2 cusecs per million cubic feet of W.P. Mr. Venkatarama Ayyar has himself shown that the maximum capacity duty *at the head* of the canal in an unfavourable year is 100 and that is the duty to which the project is designed. That duty should therefore be adhered to. If an allowance of two cusecs per million cubic feet of W.P. is allowed, the losses will be 12 cusecs and starting at the head with 75 cusecs the duty at the heads of distributaries will be about 120 and this is the highest duty which can be allowed. Next comes the much more difficult question of the velocity to be adopted to prevent silting. Here we must be guided mainly by the experience in the Mahanadi canal. Observations are now being taken to ascertain what the critical velocity is at F.S.L. and when these are ascertained I should like the question referred to me with the recommendations of the local officers.

25th March 1929]

I inspected the first 4½ miles of the line. The head is an almost ideal place to make an experiment with an upstream leading channel and it should be so designed. Mr. Venkatarama Ayyar's estimate did not provide for a scouring sluice, but I think that one is absolutely necessary. We may take the form of a single lift shutter 30′ × 6″ with sill 4′ below present crest of anicut.

According to the present proposals only outlets are provided in the first 4 miles of the channel, but I think that when the drainage is likely to be large, say exceeding 2 square miles, a super-passage or under-tunnel will be required. There is no map showing areas to be drained and in the list shown me some seemed much under-estimated. These require checking. There are no well defined drainage courses at present, but it has to be considered whether when the flood discharge is concentrated at selected points claims for damages will not arise. This applies whether outlets or other forms of escapes are adopted.

At about 4 miles 2 furlongs, there is a big cutting ½ a mile long and maximum depth 22′. This is stated to be all gravel and in Mr. Venkatarama Ayyar's report it is said that trial pits have been taken. Enquiries on the spot showed however that only one pit was dug and that it is quite doubtful if that were sunk to full depth. The old pit should be re-excavated to full depth or till rock is met and 6 borings should be taken as well. Even if these prove as satisfactory as anticipated some allowance for the rock which is almost certain to be found should be made. The Superintending Engineer has already given instructions about making provision for draining the slopes of the cutting and these should receive attention.

5. *Surada reservoir.*—Inspected a portion of the west * and the whole of the east bunds. The tank was at F.S.L. and I was unable to see the lower portions of the revetments. Judging from what was visible of the front slope they must be in good order as is the rear slope throughout. From 0·1 to 0·3 of west bund there is good deal of leakage. Unfortunately the fencing and demarcation stones are absolutely at the toe of the bund and there is no room for a drain. There is in one place wet cultivation up to the toe of the bund. It seems most unlikely that in the first instance a strip was not taken up and the Executive Engineer should examine the original land plans to see if the Public Works Department stones are in the right place. If they are, it is necessary to take up about 100 feet of land at the toe. At about 0·3 there is a distinct spring under the bund. The water coming out is gauged by a notch and it is stated that the discharge does not vary whatever may be the head in the tank which would indicate that it is a spring and not a leak through or under the bund. It would however be advisable as a precautionary measure to put down a puddle trench at this point and this should be done when the water falls low enough. I understand that when the tank falls to about 18 feet on cill of sluice this portion of the tank is cut off from the rest of it and that it is impossible to drain this depression although it is about 12 feet higher than the sluice cill. When the tank next falls low enough a cut should be made on the most economical line to drain this end of the tank.

* Called south in the completion report.

East bund.—The deepest bed of the tank is near furlong 0·1 and 0·2 and here the bund seems in good order and there is not much seepage, but not nearly enough care has been taken in draining the toe which rests on sloping

ground easily drained into the hollow a little further off. The drains have been allowed to silt up. They should be cleared and extended where necessary.

At about 0·7 in eastern bund there is a great deal of leakage which is not properly drained. A drain parallel to the toe is required and cross drains leading to it.

The head sluice is in good order except for the gearing which is not properly looked after or properly lubricated. It works very stiffly as was foretold by Mr. Hughes in his inspection notes printed in G.O. No. 211 I., dated 1st March 1897. he stiffness is however greatly augmented by the use of liquid fuel as a lubricant for which purpose it was utterly unsuited. Between the sluice and surplus weir the bund although of no great height shows signs of cracking very badly. I am informed that these cracks are filled in with metal and gravel. This is not suitable as it is impossible to force such material down for any distance. The cracks should be filled with dry sand poured in slowly so as to penetrate the cracks as deeply as possible.

Padma surplus weir.—At extreme right flank, the surplus channel in rear has cut back in two places, the easternmost gully having reached the dry stone apron which is beginning to collapse. This is not very deep. The other gully is still about 200 feet short of the apron but is much deeper. A second drop is required which must be built about 240 feet below the existing apron. The level of this apron is + 288. The new weir may have its crest at + 285 and its apron at + 279 which is the level of the surplus channel further down. The apron may be of rough stone in mortar built in edge, the foundations being designed to suit the nature of the soil found The strip of high ground in rear of the weir may be retained and the walls tied into it, with dry stone revetment wings, as a protection both front and rear.

6. *Janamilli anicut* and head works of Rushikulya canal. The anicut is, as far as I could see, in good order. The beams of gearing of head and scouring sluices are old and a good many need replacing. An estimate for this is under consideration by the Executive Engineer. When the under-sluice shutters are first closed there is a great deal of leakage which is said to be over the top of the shutter. This should be seen to and stopped as the water which reaches Janamilli anicut is very largely that issued from the reservoir and should be carefully conserved.

7. *Rushikulya canal.*—Breach at 1 mile 6 furlongs right bank. This occurred in 1911. The ground is not low here but the soil is liable to crack and as it is on the outer edge of a curve in the canal it is inclined to scour. Protective measures to encourage a silt berm are necessary and probably revetment after a berm has formed.

Aqueducts at 9 miles 1 furlong and 9 miles 6 furlongs.—In both of these the wings and returns in rear are badly cracked. In the latter the returns are pushed forward and are likely to fall. In the case of the aqueduct at 9 miles 6 furlongs the rear wings and returns should be re-built to a proper section at once. They are heavily surcharged and I believe it will be found that the section is insufficient. Most of the wings and face walls about here seem to be weak and will have to be re-built eventually.

No. 2 Distributary.—The sanctioned area is 2,200 acres, but all of this except 246 acres has been relinquished since the resettlement. It seems probable that the first bad year will bring the lands under irrigation again.

25th March 1929]

The arrangements for disposing of cross drainage here are not satisfactory and this year the bank breached just below the head sluice. A pipe inlet has been provided, but I am not sure that it is enough for the area drained. The question should be enquired into.

Shergadda cutting—about a mile long. Considerable expenditure has been incurred in revetting and draining the left bank and it is in good order, but the masonry drains should be altered so as to give free outlet to the water where it passes through cuts on the spoil bank. The right bank has not received so much attention and there are several small slips. These will have to be revetted and it looks as though more cuts in the spoil bank were required.

Just above the bridge at 12 miles 3 furlongs the canal passes through Sagaram tank at a much lower level than the tank. The tank is used and the water level was dangerously high. The canal bank should be raised to 3′ above M.W.L. with a minimum top width of 6′ to the bank.

No. 3 Distributary has never been constructed as the Shergadda Zamindar did not care to take water to his rainfed paddy even at the original rates. At those now charged there seems no likelihood of his doing so.

From 36·0 *to* 37·5.—The bank even on this date a fortnight or so after heavy rain shows signs of cracking and is rather thin in places, while there is much percolation water standing at the toe, partly due to defective drainage and partly to an old tank through the upper part of the water-spread of which the canal passes. It would probably be possible to improve matters by breaching this in several places as it does not look big enough to do any good. There was a breach in 1911 at about 37·4. At 37·5 is an aqueduct the side walls of which leak a good deal and should be seen to. The approaches are rather steep but not so bad as those at 46·5 and 47·2. Just below this aqueduct there was a breach in the right bank in (I think) 1909. There seems no reason why it should have breached here as the section is good and the soil does not look bad.

9th Distributary.—The head sluice gearing wants attention and the revetment in rear should be extended on the left.

At about 39·0 there is a fairly high bank with a great deal of percolation through it. This requires careful watching. Below this is an important outlet. F.S.L. is at the top of the lower row of shutters which are about 9″ wide. There were complaints of injury to crops from this surplus work which has no well defined channel in rear. I could however see no signs of damage by the discharge which must have occurred in the recent cyclonic rain and as surplus channel would be very expensive I do not think that any action is necessary.

Ichchapur channel at 39·4½ on right bank head sluice 4 vents each 6′ × 4′. Irrigation under channel 30,000 acres. The gearing to the head sluice is very badly looked after, many bolts are missing and those that are there are not screwed up, with the result that the gearing is being worn out. I saw vegetation growing in the rear wing. The work has a neglected appearance.

Drop at 39·5.—Fourteen feet high water cushion 3′ deep with concrete floor which is said to require repair.

At 42 miles 4 furlongs a breach occurred on 1st August of this year. It was at the site of a pipe; the rear slope of the bank at this place was very

steep and this was possibly the cause. It is not a dangerous place. It seems as though a pipe at this place were quite unnecessary as the lands can be commanded from another pipe on the ridge about 300 yards away.

Aqueduct at 46·5.—The wings are too short and the slopes too steep; water wings are required and the bund should be made up to cover a hydraulic gradient of 1 in 4. Just above this aqueduct was a breach in 1911. This is said to have occurred by leakage through a crack, and there is no doubt that this portion of the bund requires attention. If gravel can be obtained fairly close by, it would be well to gravel the front slopes of this portion of the bank for a thickness of 6″.

At 47·2 is an aqueduct of a similar design to that at 46·5 and the same measures are required.

At several places in the canal there are pipe sluices which are far too short. These should be made to the proper length and when their position and size are finally fixed, front and rear walls should be built.

After having inspected most of the weak places in the Rushikulya canal, I have come to the conclusion that there is no reason why it should not be made safe from breaching in ordinary circumstances. I have indicated above what is required at various points and generally speaking it may be said that careful conservancy and inspection will do much to prevent breaches early in the season. Every opportunity should be taken to let into the canal early in the season any floods which may occur even though the water is not required for irrigation in order to moisten the banks. A weak point in the canal is the absence of any regulator or proper surplus work throughout its length so that a breach near the end necessitates cutting off the supply at the head. I am not prepared to say where a regulator and surplus work could be made most conveniently, but they should be built preferably somewhere between 30th and 40th mile.

8. I inspected a portion of 13th Distributary which was said to give trouble. This trouble is, as far as I can see, mainly due to defective maintenance. The channel is designed to carry 120 cusecs, but as gauged only carries 72. The principal cause of this is that silt berms have been allowed to form and unduly constrict the channel. Similarly, there is a complaint of insufficient bed fall in the lower reaches, but I am not certain that this is not mainly due to defective maintenance. When I inspected I found weeds and vegetation growing across the channel.

A pleasing feature was the efficiency of the old-fashioned drops discharging on to rough stone in mortar aprons without any water cushions. They appeared cheap and effective, though they would be improved by the notch being trapezoidal and a lip to splay the water.

General.

9. Apart from actual works, a great deal is required to make the system efficient. A good working map is required showing all branch channels and minor distributaries. At present I understand that there is nothing but the sketch map of the system which is undoubtedly most sketchy. I do not think that an expensive ayacut map with contours is required.

Ayacut registers and pipe lists are required and rules for regulation at the reservoirs, head works and for channels are required. Proper use

25th March 1929]

should be made of the channel lascars who should not only regulate the sluices in order but should have specific tasks allotted to them in clearing weeds in channels, filling gullies and cracks in banks, etc.

I have had the advantage of reading a note by the late Executive Engineer, Mr. R. N. Arogyaswamy Mudaliyar, on what he considers necessary to extend and improve the system. I do not wish to express an opinion on the proposals therein made as I believe that the Superintending Engineer will deal with them in due course. I will only remark that it is altogether premature to consider extending irrigation until the system is put into good order. I would, however, except from this the Girisola channel, the estimate for which has been under preparation for a long time. The programme I would suggest placed in order of urgency is as follows :—

(1) Fitting two shutters to the Gumsur anicut.

(2) Altering shutters to Mahanadi head sluice.

(3) Altering gearing to Gumsur anicut under sluices.

(4) Scouring vents to aqueduct in Mahanadi canal.

(5) Improvements to aqueduct at 1 mile 6 furlongs, Mahanadi canal.

(6) Strengthening weak places in the Rushikulya canal as denoted in paragraph 7 supra.

The construction of the lower drop wall below the Padma weir is also very urgent, but I have not included it in the above programme as it does not concern the arrangements to be made for passing water freely down the canals.

All the above should be taken up this year.

JAYAMANGALAM CHANNEL—21ST NOVEMBER 1912.

This channel is a natural drain utilized for the purpose of irrigation and provided with an anicut and head sluice about the year 1865. Owing to its alignment it presents the greatest possible difficulty to satisfactory irrigation from it and various proposals have been made for its improvement or abandonment, but, as far as I can understand, no definite scheme has yet been evolved. Mr. Arogyaswamy Mudaliyar in his note mentioned in paragraph 9 sketched out a scheme for bringing it under the Rushikulya project. There are obvious financial objections to this and, if possible, the system should be retained as it is a separate Class IV work. From the levels which have already been taken I suggested a method of dealing with the upper portion of this channel. The most pressing need is, however, I understand, the improvement of the irrigation under Koratoli Tampara, a tank depending for its supply on the Jayamangalam channel. These improvements can be worked out independently of what is done to the channel and should be taken up first.

H. E. CLERK,
Chief Engineer for Irrigation.

[25th March 1929

IV

G.O. No. 566 *I., dated* 12*th December* 1912.

Communicated to the officers concerned.

2. The attention of the Superintending Engineer, I Circle, will be drawn to the remarks and suggestions of the Chief Engineer for Irrigation. Special steps should be taken to carry out as early as possible the works recommended in paragraph 9 of the Inspection notes.

3. The Government consider that the works in the Rushikulya system have not been maintained in as efficient a state as they should have been and look for improvement in that respect.

(True extract)

H. E. CLERK,
Joint Secretary to Govt., P.W.D.,
Irrigation Branch.

APPENDIX VII.

[Vide answer to question No. 1858 asked by Mr. C. Ramasomayajulu at the meeting of the Legislative Council held on the 25th March 1929, page 723 supra.]

Paragraph 3 *of G.O. No.* 1134, *Revenue, dated* 6*th December* 1887.

3. The most important point requiring consideration, however, is the determination of the commutation prices to be adopted for converting the grain values into money rates. This subject has been fully discussed by the Deputy Commissioner, Messrs. Glenny and Grose, and the Board. The strict application of the principle laid down in paragraph 6 of Government Order, dated 30th July 1885, No. 881, viz., that where the average of the market prices of the staple grains for the twenty non-famine years immediately preceding the settlement, *minus* such allowance as may be found necessary for the difference between the ryot's prices and the market prices, exceeds the lowest market price during the same period, the latter should be adopted as the commutation rate, has been shown, in the case of South Arcot, to entail a needless and unjustifiable sacrifice of the resources of the State. The loss of revenue was calculated by the Deputy Commissioner (vide scheme A) at 2 per cent on wet and no less than 36 per cent on dry lands, aggregating Rs. 1,66,184 for the two taluks of Cuddalore and Villupuram alone, but it would really be very much greater, as a deduction of one-seventh has to be made from the rates adopted for scheme A, it having been since discovered that the quotations in the Board's lists of prices are in terms of garce of 3,200 *local* measures of capacity one-sixth greater than that of the Madras measure. It is thus clear that the rule laid down as regards the determination of commutation rates requires modification. His Excellency the Governor in Council, after a careful consideration of the question, resolves to accept the method suggested by Mr. Grose, viz., that of taking the average of the twenty non-famine years, deducting therefrom 15 instead of 10 per cent on account of the difference between the ryot's and the market prices, and this decision will be reported to the Secretary of State for confirmation.